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EXECUTIVE SUMMARY

LIF WASTE CHARACTERIZATION FOR HANDLING/DISPOSAL INTERIM PROGRESS REPORT TO APRIL, 1985

A. Golomb

Preparatory to a trial of direct limestone injection into the furnace (LIF) for acid gas control, to be held at Lakeview TGS in fall, 1985, laboratory tests have been carried out to anticipate the physical and chemical characteristics of the solid waste produced, to facilitate safe handling and disposal. A sample of Consol LIF waste, obtained from the USA, was found to have a CaO content of 333 g/kg; in calorimetric tests it reacted exothermically with water (ΔH = -68.9 cal/g). Leachate derived from the 'as received' waste had pH 12.4. In bulk slaking tests, internal temperatures up to 160°C were noted, accompanied by ~15% linear expansion. Particle size analysis showed the slaked material to be finer than the original waste. The need for care in handling and disposal of LIF waste is therefore evident. A block experiment is under way to predict leaching characteristics of the landfilled waste prepared using various levels of added water, added fly ash, and curing times at summer and winter temperatures. Standard MOE leachate extraction tests and detailed physical tests are planned, to assess hazardous waste classification (if any) and potential of the waste for use as landfill or backfill. Complete experimental results will be reported in due course.

job	file	date	report no.
740631-232-901	837.2412	June 11, 1985	85-134-K

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LIF WASTE CHARACTERIZATION FOR HANDLING/DISPOSAL INTERIM PROGRESS REPORT TO APRIL, 1985

A. Golomb

To facilitate safe handling and disposal of solid waste resulting from a scheduled trial of acid gas control by limestone injection into the furnace (LIF) at Lakeview TGS, preliminary tests were carried out on a sample of Consol LIF waste obtained from the USA. The Consol waste had a CaO content of ~333 g/kg, and reacted exothermically with water (ΔH = -68.9 cal/g). Leachate derived from the 'as received' Consol waste had pH 12.4. In bulk slaking tests, internal temperatures of 160°C were observed; this was accompanied by ~15% linear expansion. Particle size reduction on slaking was also noted. The need for care in handling and disposal of LIF waste is therefore evident. Experimental work continues to predict leachate extraction characteristics and physical/engineering properties of the waste treated for disposal as landfill.

INTRODUCTION

Ontario Hydro plans to determine the feasibility of acid gas emission control by direct injection of limestone into the furnace (LIF). Tests are scheduled to take place at Lakeview TGS in the fall of 1985. It has been suggested that handling and disposal of the resultant limestone-modified fly ash (LIF waste) could pose problems due to the expected high CaO content. Such problems might include:

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(i) exothermic reaction of the waste (containing up to 40% w/w of calcined limestone, ie CaO) when wetted,

(ii) potential for pozzolanic reaction of mixtures of fly ash and CaO with water,

(iii) leachate problems that might occur in relation to landfill disposal

and

(iv) dusting problems arising from handling/disposal of the waste when dry.

A brief, exploratory LIF test was carried out at Lakeview TGS, on January 29-30, 1985, resulting in production of about 300 Mg of waste, which was hauled by tanker truck for temporary dry storage in a silo at Hearn TGS. Alternative disposal options for this waste are being investigated by a specially-appointed task force.

WORK PROGRAM

To generate useful data for design and development of safe, effective methods for handling and disposal of LIF waste to be produced at Lakeview TGS in fall, 1985, and at other coal-fired stations in the future, the research program outlined below has been initiated. The LIF material selected for testing purposes (at least, initially) is Consol limestone injection waste, obtained from recent tests using eastern US bituminous coal (sulphur content ~2.5% w/w) at the DuPont Inc nylon production plant at Martinsville, Virginia, USA. Consol waste is presently considered to be the best available substitute for the fall, 1985, Lakeview LIF waste, since it is known to have a high CaO content resulting from calcination of limestone and a modest degree of sulphation.

1. Initial Waste Characterization

   - chemical analysis, exothermicity measurements, particle size determination, and MOE leaching tests

2. Waste Fixation/Screening

   - preliminary setting tests with combinations of Consol waste, Lakeview TGS fly ash, and water - followed by waste fixation experiments and screening to identify the (approximately) five best candidates for further, detailed testing

3. MOE Leachate Extraction of Selected Fixated Waste

(a) using deionized water and
(b) with pH adjustment in accordance with the 1984 Leachate Extraction Procedure

4. Engineering/Physical Tests of Selected Fixated Waste

- further engineering tests (eg compressibility, permeability etc) of selected fixated waste samples to check suitability for landfill use.

5. Slaking/Pelletizing Equipment Evaluation

- samples of Consol waste to be sent to commercial equipment suppliers for evaluation.

All test results will be evaluated to gain useful information for safe, effective handling and disposal of LIF waste expected to be generated in the fall, 1985, Lakeview test and beyond.

PROGRESS TO APRIL, 1985

Chemical Analysis

The major chemistry of Consol LIF waste has been determined. Analytical results are given in Table I. For comparison, available chemical analyses of LIF waste sampled during the January, 1985, exploratory test at Lakeview TGS are included. CaO content was determined for 10 individual tanker-loads of LIF waste leaving Lakeview TGS for storage in a silo at Hearn TGS. The highest CaO tanker load was identified. A composite sample was also made up from the 10 tanker-loads. LIF waste samples were taken during the test from a dedicated electrostatic precipitator hopper in the morning and afternoon of both January 29 and 30, 1985. From Table I, it is apparent that the Consol waste and the hopper waste samples (which had the highest CaO content) should be more representative of the LIF waste expected to be generated in the fall, 1985, test than any of the tanker waste samples. There is evidence that CaO in the tanker-truck LIF waste was diluted to varying degrees by regular fly ash formed during the test run (i) at times when limestone injection rates were low or nil and (ii) by fly ash originating in the other boiler unit connected to the common silo from which the tankers were loaded.

The highest CaO content of the hopper samples (331 g/kg) occurred on the afternoon of January 29, 1985, when limestone injection rates reached their peak.

TABLE I

CHEMICAL ANALYSIS OF CONSOL LIF WASTE AND LAKEVIEW TGS (JANUARY, 1985) LIF WASTE

Species	Consol LIF	LVTGS 10-Tanker Composite	LVTGS High-CaO Tanker	LVTGS Hopper LIF 840129 AM	LVTGS Hopper LIF 840129 PM	LVTGS Hopper LIF 840130 AM	LVTGS Hopper LIF 840130 PM
CaO	333 (270)	75	160	240	331	278	268
$Ca(OH)_2$	- (<30)	(<30)	(<30)	(<30)	(<30)	(<30)	(<30)
$CaSO_4$	182 (190)	35	51	61	55	55	52
$CaCO_3$	80 (50)	8	12	(<30)	(<30)	(<30)	(<30)
Unburnt Carbon	129	86	92	-	-	-	-

All concentrations given in g/kg. Results of analysis by XRD are given in parentheses.

The $CaSO_4$ content of the Consol waste was about three times higher than that of any of the Lakeview January test samples: this may reflect poor sulphation efficiency in the Lakeview January test, which could in turn be due, at least partly, to dead-burning.

If we assume that the LIF waste to be produced in the fall Lakeview test will resemble the Consol material, safety precautions will have to be taken with respect to the expected high CaO content. Dusting must be avoided during handling operations, and the waste carefully and efficiently slaked prior to disposal, eg as landfill.

Exothermicity Tests

The heat of reaction of Consol waste with water was measured using a styrofoam-jacketed nickel calorimeter and stirrer of total water equivalent 10.9 g. The stirrer, which had a rotational speed of 60 rpm, was used for the first 1 min of each run, and then switched off to minimize frictional heat. Forty-gram quantities of Consol waste were allowed to react with various amounts of water, and the exothermic reaction temperatures plotted versus time. For this purpose, a copper-constantan thermocouple was used for temperature measurement. A Hewlett-Packard HP-85 microcomputer and a HP-3421A data acquisition/control unit were used for data collection/reduction.

Results are given in Figure 1, which shows that the maximum temperatures observed are inversely related to the amounts of water added. (This is as expected, since at higher liquid/solid ratios the heat of reaction is dissipated into a larger 'heat sink'.) The highest temperature reached in these tests (~100°C) was for 10 g water added to 40 g Consol LIF waste; water vapour condensed on the cooler parts of the apparatus under the conditions. To measure the heat of reaction, temperature/time curves corresponding to larger amounts of added water (ie 35 g, 45 g, and 60 g water added to 40 g Consol waste) were selected for use. Applying a cooling temperature correction/1/ for cooling by projecting the near-linear cooling section of each plot back to time zero, values were calculated for the heat of reaction of Consol waste with water; results are given in Table II.

The average calculated heat of reaction of Consol waste with water ($\Delta H \approx -68.9$ cal/g) is equivalent to about 30% of the heat of slaking of quicklime ($\Delta H \approx -230$ cal/g). This is in good agreement with the observed 33.3% of CaO (27.0% by XRD) found in Consol waste. The heat of slaking of CaO is known/2/ to be liberated much more rapidly than the heat of hydration of

LIMESTONE INJECTION FURNACE

CALORIMETRY: TEMP (C) VS TIME (SEC)

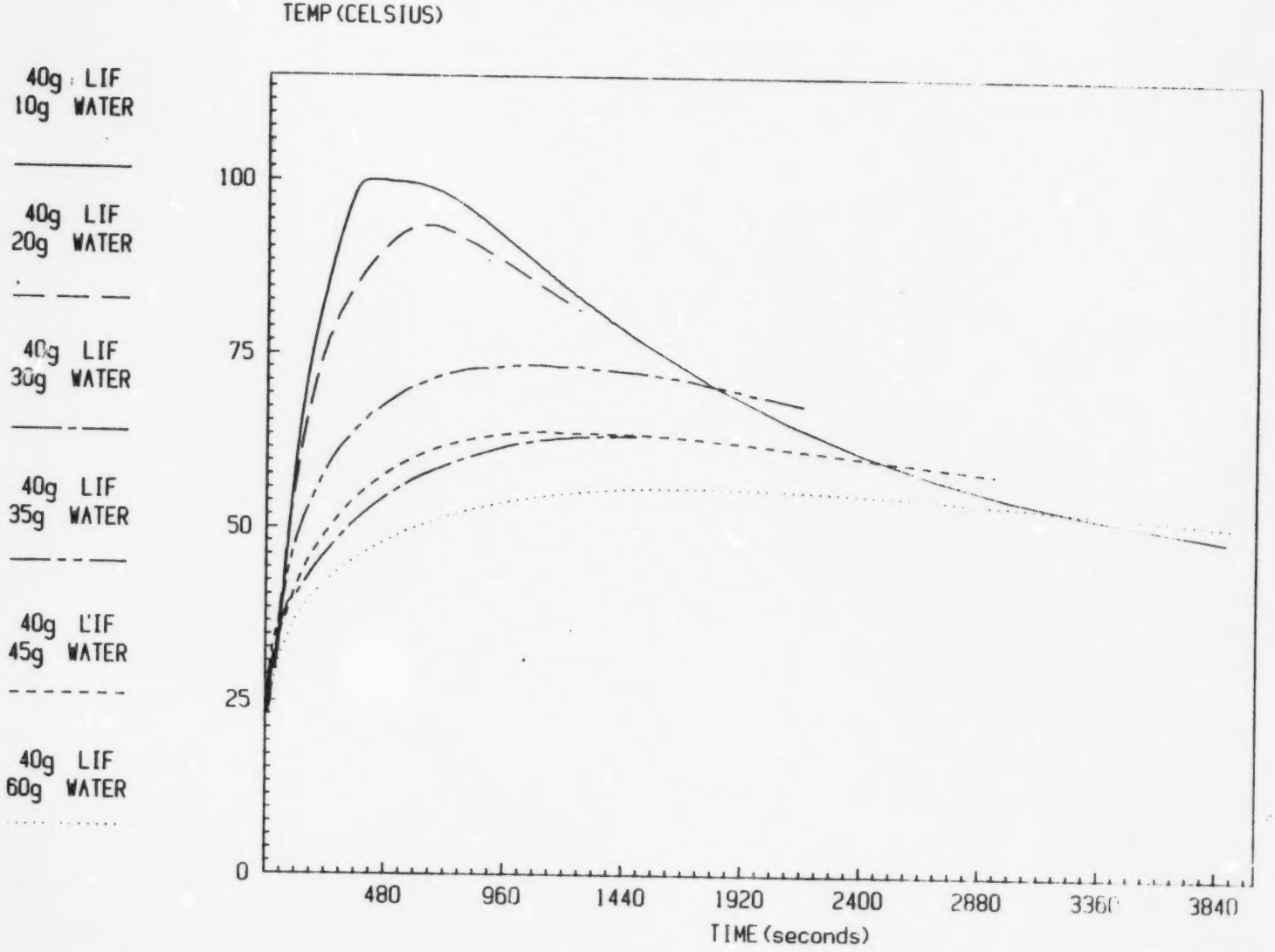


FIGURE 1

TABLE II

CALCULATED HEAT OF REACTION OF CONSOL LIF WASTE WITH WATER

Wt of Consol (g)	Wt of H_2O (g)	Temp Projected Back to Time 0 (°C)	Ambient Temp (°C)	Water Equivalent of Calorimeter (g)	ΔH (cal/g)	
40	35	84.1	23.5	10.9	-71.4	
40	45	70.2	23.5	10.9	-66.6	Av = -68.9
40	60	61.5	23.5	10.9	-68.6	

anhydrite (ΔH ~ 30 cal/g) - the most probable form of $CaSO_4$ in Consol waste. Since strong, concrete-like setting was not observed in the cured material (it was friable) it is considered improbable that the heat of bonding between lime and fly ash could have contributed much heat to that observed. In summary, the observed heat of reaction between Consol LIF waste and water is attributed predominantly to the slaking of CaO.

Exothermicity tests were also carried out on samples of LIF waste generated during the Lakeview January trial. Results are given in Table III.

Although CaO analysis of Consol LIF and hopper LIF (January 29, PM) wastes were about the same (~33% w/w) the hopper material generated far less heat on slaking. The hopper material may well have been dead-burned, which would account for its relative lack of reactivity. During the January test, limestone was injected at the top row of burners, where temperatures were well in excess of 1 050°C (the commonly-accepted threshold temperature for dead-burning).

Bulk Exothermicity Test

For safety reasons, it was of interest to measure the maximum temperatures attainable within a mass of LIF waste when exposed to small amounts of water during bulk handling or storage, ie. where mechanical mixing action is practically negligible.

About 2 L of Consol LIF waste was lightly packed into a cylindrical container of rigid styrofoam (internal dia 14.0 cm, height 15.5 cm), fitted with a rigid styrofoam lid. The underside of the lid was equipped with a water distribution coil, made of perforated silicone tubing. Deionized water was pumped from a reservoir via a calibrated Cole-Parmer peristaltic pump at ~3.7 mL/min over the top of the bulk Consol waste, and allowed to percolate down through the material. This application rate corresponds to a rainfall of ~1.63 cm/h which, based on meteorological data, is possible for southern Ontario. Three thermocouple probes were located axially at 10 cm, 7 cm and 4 cm above the base of the container. As the water front passed downward, the rise in temperature at each probe was measured and recorded (Figure 2). The maximum temperature observed within the bulk material was ~160°C. This is higher than the ~100°C maximum observed in the most strongly exothermic calorimetry test. The high bulk slaking temperature is attributed to poor thermal conductivity of the LIF waste, which did not effectively dissipate the heat. The final, slaked bulk material was found to have expanded by ~15%, ie. from 14.0 to 16.2 cm dia at the middle. In practice this expansion could damage or rupture containing vessels, eg tankers, silos etc, unless steps are taken to avoid uncontrolled water addition during handling.

TABLE III

EXOTHERMIC REACTION TEMPERATURE OF LAKEVIEW (JANUARY, 1985) LIF WASTES WITH WATER

Waste	CaO Content (% w/w)	Maximum Temperature (°C) Observed	
		40 g Solid + 10 g Water	40 g Solid + 30 g Water
Hopper LIF 850129 AM	24	38.4	29.4
Hopper LIF 850129 PM	33.1	51.2*†	51.5*†
Hopper LIF 850130 AM	27.8	34.3	28.3
Hopper LIF 850130 PM	26.8	35.6	29.8
10-tanker composite	7.5	29.0	25.2
High-CaO tanker	16.0	28.4	26.7
Consol LIF (for comparison)	33.3	~100†	71.2†

* Anomalous equality of maximum observed temperatures (both were re-checked).
† Maximum temperatures lower for Hopper material than for Consol waste

CONSOLIDATED WASTE
BULK EXOTHERMIC STUDY

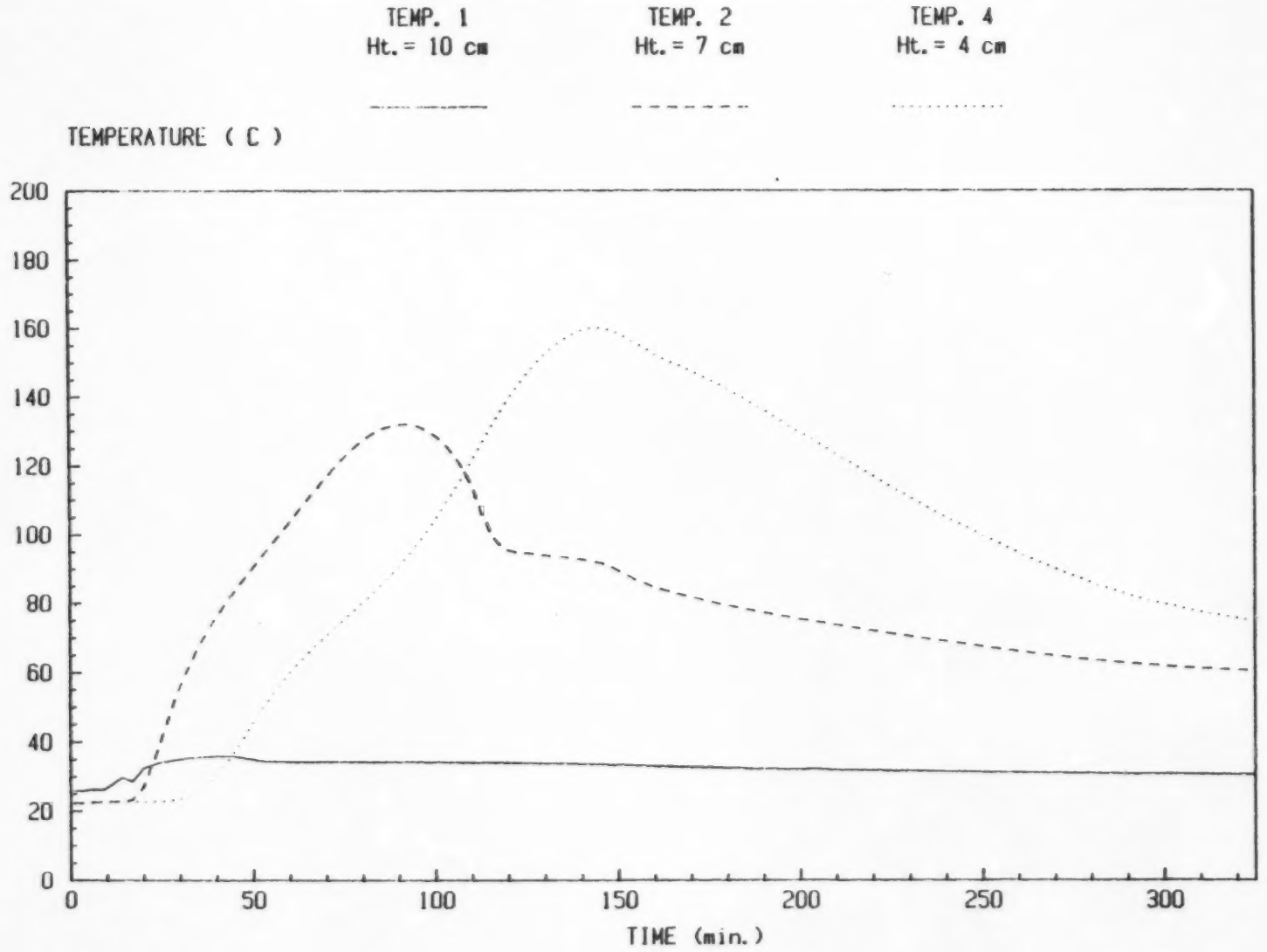


FIGURE 2

If the waste were landfilled dry (ie unslaked), moreover, expansion inevitably resulting from infiltration of water would probably result in heaving and fissuring, with attendant loss of structural integrity, as well as creating steam and dusting problems in the vicinity.

Particle Size Determination

Particle size distribution measurements were made using an HIAC Particle Size Analyzer (Model PC-320). Determinations were made on Consol LIF waste 'as received' and on a sample of the dry, slaked material remaining after reacting 40 g Consol waste with 10 g of water (Figure 1, highest exotherm). Results are given in Table IV.

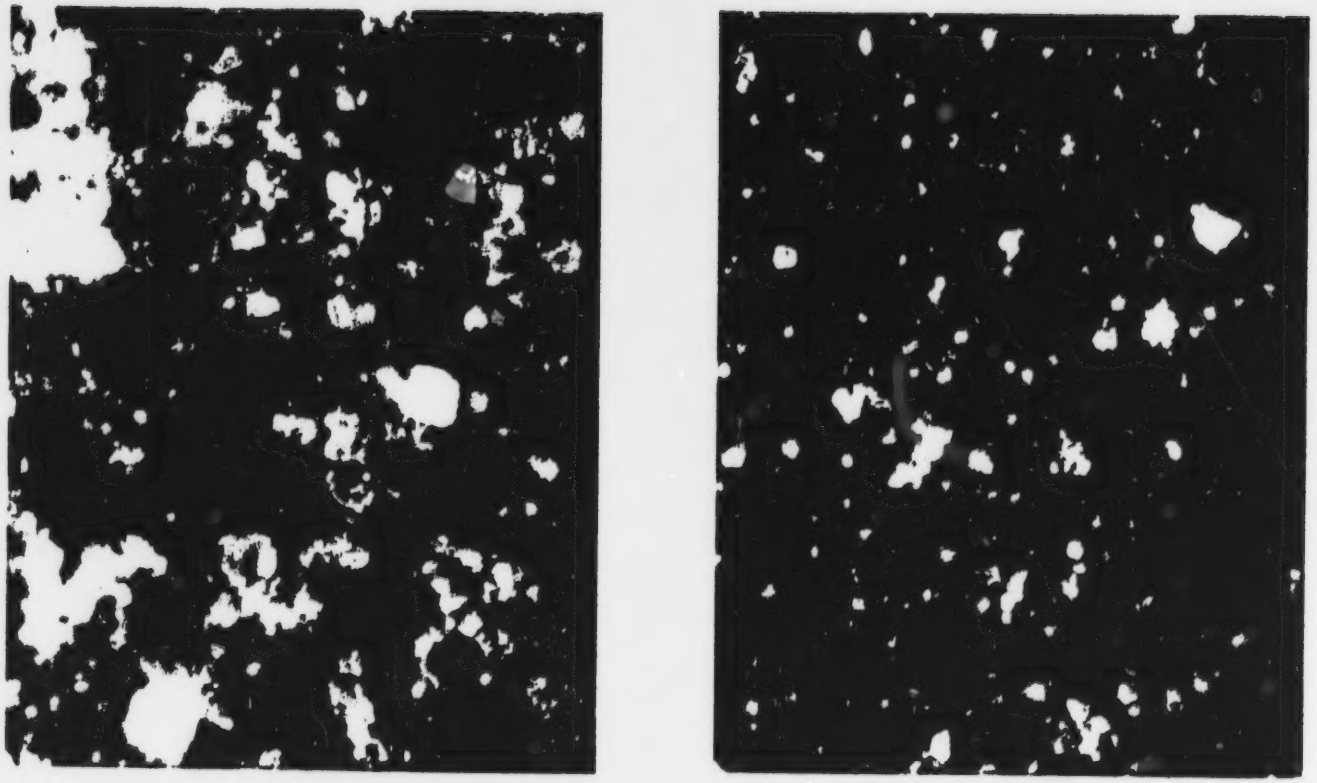
TABLE IV

HIAC PARTICLE SIZE ANALYSIS OF CONSOL WASTE 'AS RECEIVED' AND AFTER SLAKING

Size Range (μm)	No. of Particles/mg Sample*	
	'As Received'	Slaked
5 - 10	33 550	46 800
25 - 50	2 000	7 150
50 - 100	362	770
>100	32	52

*Note: Increase of number of particles per mg sample in all size ranges is attributed to exothermic (slaking) chemical reaction, in which heat and steam evolved causing breakdown of all reactive CaO particles.

It is seen from Table II that the material became finer when slaked. This observation is supported by optical microscopy (Figure 3) at 90X magnification. The heat of reaction was sufficient, moreover, to evaporate the remaining water and leave a dry residual product. For handling/disposal of slaked LIF waste, it is essential that appropriate steps be taken to avoid dusting problems associated with the finely-divided material.



(a) (b)

FIGURE 3

Consol Waste: (a) 'as received', (b) after slaking

(90X magnification)

MOE Leaching Tests

A set of leaching tests was carried out to determine the leaching characteristics of the 'as received' Consol waste. The test procedure used is essentially that proposed by the MOE in October, 1984. To gain maximum information, leaching tests were conducted under aerobic as well as anaerobic conditions, with and without addition of acetic acid for pH adjustment. The extract obtained using deionized water had pH 12.4 at 22°C. Chemical species being analyzed in the leachates are: As, Ba, B, Cd, Cr, W.A.D.[1] CN^-, F^-, Pb, Hg, NO_3^- (as N), NO_2^- (as N), Ra-226, U, Se, Ag, Cl^-, Cu, Fe, Mn, N (organic), phenols, SO_4^{2-}, TDS, TOC, PCBs, and Zn. The results will be interpreted to predict hazardous waste category (if any) and suitability of the uncured LIF material as landfill or backfill.

Waste Fixation - Preliminary Tests

To gain some idea of the physical handling characteristics of LIF waste and of LIF waste/fly ash after mixing with water, a series of preliminary tests was carried out. It was hoped that the results would provide a key to selection of conditions for rendering the waste suitable for landfill disposal.

Samples of Consol LIF waste after exothermicity testing (slaking) were removed from the calorimeter and air-dried in the open laboratory at 23-24°C for 24 h (Figure 4). As previously noted, the basis of these tests was 40 g of dry Consol material; amounts of water added were 10 g, 20 g, 30 g, 35 g, 40 g, 50 g and 60 g, respectively. It was found that water additions of 10 g, 20 g and 30 g gave products ranging from dry, to moist, to moist/lumpy. Water addition of 35 g gave a smooth paste that set lightly over 48 h to a plaster-like solid. Higher levels of added water resulted in phase-separation; solid material settled out under an aqueous supernatant layer. When the excess water evaporated off at room temperature (~48 h) the solid material set lightly, with a weak crusty layer on top, resembling 'dried mud'.

Samples of Consol LIF waste were mixed with various proportions of added Lakeview fly ash (total weight of dry solids = 40 g) covering the entire range from 100% fly ash to 100% Consol LIF with seven intermediate blends. Water was thoroughly blended with each mix to a wet plaster-like consistency, which (except for 100% fly ash) took on a moderate set in the open laboratory after 24 h, during which time some drying-out took place (Figure 5). The maximum temperatures observed in these open-laboratory tests were, as expected, considerably lower due to

[1] W.A.D. CN^- denotes weak acid dissociable cyanide.

FIGURE 4

Consol Waste/H_2O - Preliminary Fixation Samples

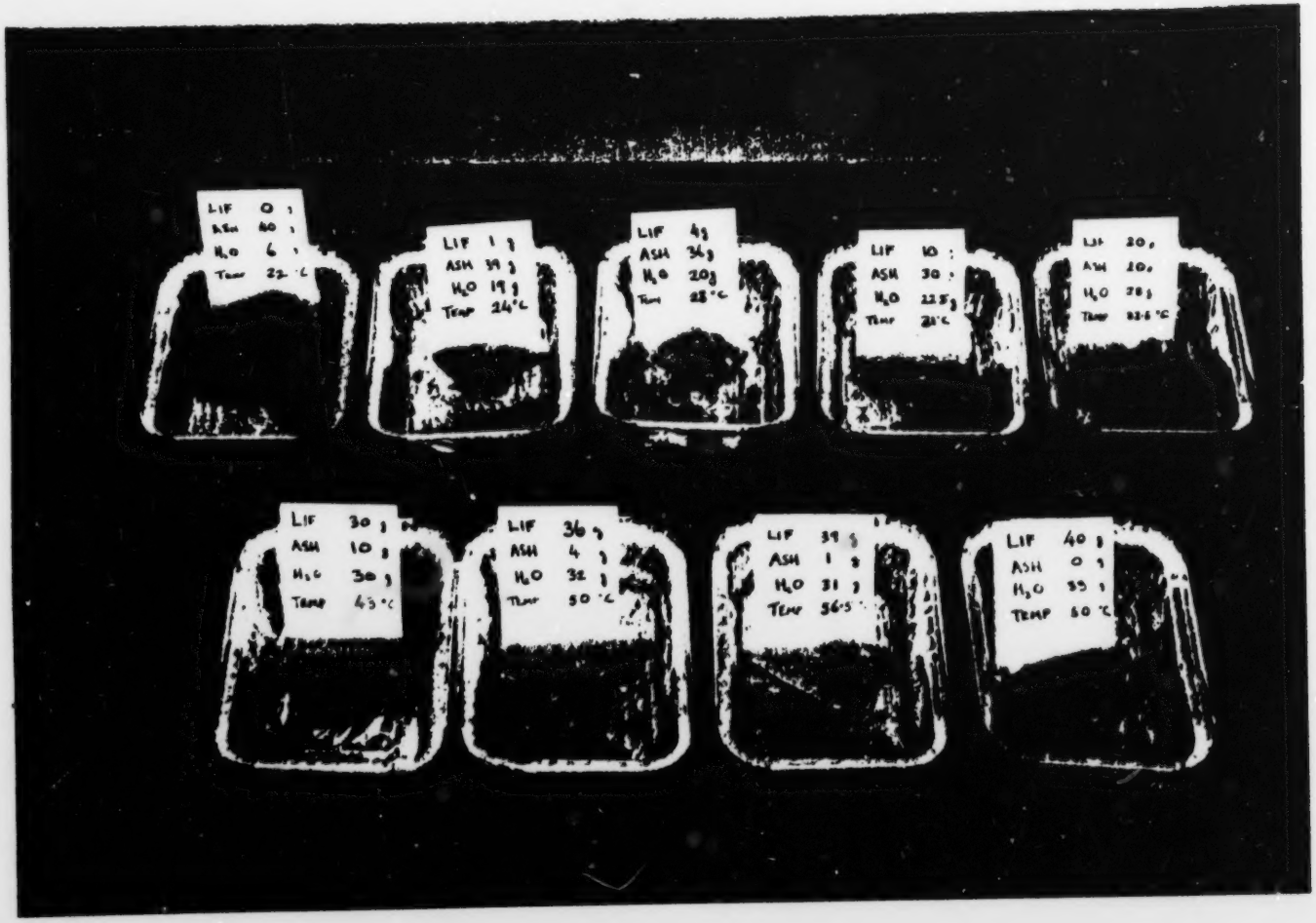


FIGURE 5

Consol Waste/Fly Ash/H_2O - Preliminary Fixation Samples

heat loss than those noted earlier in the calorimetry experiments. The various conditions and corresponding open-laboratory temperatures reached are summarized in Table V.

TABLE V

BLENDS OF CONSOL LIF WASTE AND ADDED LAKEVIEW TGS FLY ASH. OPEN-LABORATORY MAXIMUM TEMPERATURES ATTAINED

Consol LIF Waste (g)	0	1	4	10	20	30	36	39	40
Added Lakeview Fly Ash (g)	40	39	36	30	20	10	4	1	0
Water Added to 'Smooth Paste' (g)	6	19	20	22.5	28	30	32	31	33
Maximum Temperature Attained (°C)	22	24	28	31	32.5	43	50	56.5	50

To obtain a plaster-like set from Consol LIF/fly ash mixtures containing more than 50% w/w of Consol material (dry solids basis) it was found necessary to add 30 - 33 g water per 40 g of dry solids.

Samples of Consol waste and Lakeview fly ash were mixed to simulate the waste material produced at Ca/S ratios of 2.5 and 1.25 in Unit 4 operating under LIF conditions, with Unit 3 generating fly ash normally, the two units feeding into a common silo. This scenario was planned to anticipate conditions for the January, 1985, Lakeview test. For each Ca/S ratio, water was added corresponding to 5%, 10% w/w and higher levels of water on a dry solids basis. Addition of increasing amounts of water to 40 g dry solids resulted in formation of dry to powdery-moist products for up to 29 g of added water, at which level setting to a plaster-like product took place (Figure 6). The various conditions and corresponding open-laboratory temperatures reached are summarized in Table VI.

Waste Fixation - Block Experiment

A block screening experiment is currently under way, to prepare fixated samples of varying proportions of Consol LIF waste, added Lakeview fly ash, and moisture content; and at different

FIGURE 6

Ca:S Ratios 2.5 and 1.25 - Consol Waste/Ash/H_2O - Preliminary Fixation Samples

TABLE VI

BLENDS OF CONSOL LIF WASTE AND LAKEVIEW TGS FLY ASH.
SIMULATION OF Ca/S RATIOS 2.5 AND 1.25 IN UNIT 4 WITH
UNIT 3 OPERATING NORMALLY. MAXIMUM TEMPERATURES ATTAINED

Ca/S = 2.5	Consol LIF Waste (g)	29.8	29.8	29.8	29.8
	Added Lakeview Fly Ash (g)	10.2	10.2	10.2	10.2
	Water Added (g)*	2 (5%)	4 (10%)	15 (37.5%)	29 (72.5%)
Ca/S = 1.25	Consol LIF Waste (g)	26.7	26.7	26.7	26.7
	Added Lakeview Fly Ash (g)	13.3	13.3	13.3	13.3
	Water Added (g)*	2 (5%)	4 (10%)	15 (37.5%)	29 (72.5%)

* Figures in parentheses denote percentage water added (dry solids basis).

curing temperatures and curing times. Levels of each variable were chosen as shown in Table VII.

Samples prepared as outlined in Table VII have been subjected to accelerated screening/leaching tests under monofill aerobic conditions (no pH adjustment; air in headspace). Preliminary experimentation with Consol waste and water has shown saturation pH values of ~12.4 at 22°C. This corresponds exactly to the saturation pH of $Ca(OH)_2$. All screening test extracts are being analyzed for B, Se and As - elements which, based on past experience with leaching of US bituminous fly ash, have increased solubilities at high pH. About five of the most leach-resistant cured waste materials, ie those which the lowest extracted levels of B, As and Se, will be subjected to further, more detailed leaching tests (1984 MOE protocol) and to engineering tests for evaluation as landfill materials.

Slaking/Pelletizing Equipment Evaluation

Since dusting may prove to be a problem during handling/disposal of LIF waste, and it is at present uncertain whether equipment available on-site at Lakeview TGS or other stations will provide safe, effective means of adding water, small-scale tests of commercial slaking/pelletizing equipment have been arranged.

A 2-kg sample of Consol waste was submitted to Wallace and Tiernan, Scarborough, Ontario, for laboratory-scale slaking tests. A reply was received, stating that "the CaO will chemically combine with the silica in the fly ash ($3CaO \cdot SiO_2$) leaving only a small fraction of the original CaO to be hydrated. The results will be a very low temperature rise and an end product that will have some modest setting properties". This conclusion is surprising, since we have noted (see above) temperatures reaching ~100°C in calorimetric (slaking) experiments, and bulk slaking temperatures reaching ~160°C. The optimum temperature for paste slaking of CaO is reported/3/ to be ~88°C. We have thus far observed only plaster-like setting properties, which do not appear to reflect any high degree of combination of fly ash with silica. Clarification has been sought from Wallace and Tiernan, and a request made for a copy of their their laboratory evaluation report.

Pelletizing the LIF waste, if successful, might prove an effective way of combatting handling problems expected with this material. A 25 kg sample has been sent to Ferro-Tech, Wyandotte, Michigan, USA, for evaluation.

TABLE VII

BLOCK SCREENING EXPERIMENT FOR FIXATED CONSOL LIF

Ash (g)	LIF (g)	Water (g)	Curing Temp (°C)	Curing Time (d)
0	40	30.0	22	7
				14
			-5	7
				14
0	40	32.5	22	7
				14
			-5	7
				14
0	40	35.0	22	7
				14
			-5	7
				14
10.2	29.8	30.0	22	7
				14
			-5	7
				14
10.2	29.8	32.5	22	7
				14
			-5	7
				14
10.2	29.8	35.0	22	7
				14
			-5	7
				14
13.3	26.7	30.0	22	7
				14
			-5	7
				14
13.3	26.7	32.5	22	7
				14
			-5	7
				14
13.3	26.7	35.0	22	7
				14
			-5	7
				14

SUMMARY

Consol LIF waste is considered to be the closest available solid waste material to that expected to be produced in the fall, 1985, Lakeview test of limestone injection for acid gas control. Preliminary characterization of Consol LIF waste revealed that it contained by weight about 33.3% of CaO, <3% of $Ca(OH)_2$, 18.2% of $CaSO_4$, 8% of $CaCO_3$, and 12.5% of unburnt carbon. The material reacts exothermically with water: maximum temperatures of ~100°C have been observed by calorimetry and ~160°C under bulk conditions. The heat of reaction was estimated to be about -68.9 cal/g, attributed predominantly to slaking of the CaO. Bulk slaking was accompanied by about 15% expansion. Aqueous leachate derived from Consol LIF waste 'as received' has pH ~12.4 at 22°C, ie, the saturation pH value of $Ca(OH)_2$. Particle size reduction takes place on slaking. Twenty-four to forty-eight hours after mixing with water, either with or without added fly ash, the slaked Consol waste sets to a friable, plaster-like solid. The consistency of the freshly wetted solid waste product depends on the proportion of water added. As the amount of water added is increased up to 75% w/w of water (dry solids basis) the fresh mix ranges from dry to lumpy-moist to a wet plaster-like consistency. Above 75% w/w of added water, phase separation occurs, giving a supernatant aqueous layer. In practice, this excess water (leachate) may present a disposal problem. The region around 75% of added water appears to be of maximum interest for handling/disposal purposes.

FUTURE WORK

A block fixation experiment is under way to simulate curing of the Consol waste with and without added fly ash, with various amounts of added water. Summer and winter curing temperatures have been simulated. Different times of cure have been investigated. The fixated waste samples were subjected to an accelerated leaching test (monofill, aerobic conditions) and the extracts are being analyzed for B, Se and As, expected to be efficiently leached species at high pH values associated with presence of soluble lime. About five of the least leachable cured waste materials will be selected for further detailed leaching tests, using the MOE's October, 1984, protocol. Engineering/physical tests will also be carried out on these samples to determine hazardous waste classification (if applicable) and suitability for use as landfill or backfill. Evaluation will be made of commercial slaking and pelletizing equipment for handling and disposal purposes, since dusting and the exothermicity of the LIF waste are expected to pose problems. Expansion on slaking is considered to be another potential processing problem for landfill disposal. A detailed report of the findings will be issued in August, 1985.

'PROVISIONAL' RECOMMENDATIONS

1. Care should be exercised in handling/disposal of LIF waste in view of its potential for exothermic reaction when exposed to water at high solid:liquid ratios. Bulk slaking temperatures of up to 160°C have been noted, accompanied by about 15% linear expansion, potentially capable of rupturing storage vessels etc.

2. LIF waste poses a potential dusting problem, since the freshly formed CaO-containing material (mainly <100 μm) may be harmful to skin, eyes, and lungs if contacted or inhaled even for short periods. Respiratory equipment and goggles should be worn as a precautionary measure during handling. Freeze-drying effects in winter should be avoided as far as possible.

3. The optimum amount of water to be added to LIF waste (or to LIF/fly ash mixtures) for conditioning prior to landfill is in the region of about 75% w/w water (dry solids basis). If significantly less water is added, dusting problems may arise, while if significantly more water is added, phase separation is likely to occur, with possible problems of disposal of the excess water (leachate).

4. The potentially harmful environmental impact of leachate from LIF waste disposal, eg as landfill, should be guarded against. While concentrations of most trace metals in solution are expected to be suppressed, the high pH of the leachate (pH ~12.4) and relatively high concentrations of species such as B and Se should be monitored.

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